



Another Student

My Thesis Title

Cranfield Defence and Security
Military Operational Research

MSc

Academic Year: 2022–2023

Supervisor: Dr First A. Supervisor
Associate Supervisor: Dr Associate Supervisor
May 2023



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This thesis is submitted in partial fulfilment of the
requirements for the degree of MSc.

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Academic Integrity Declaration

I declare that:

- the thesis submitted has been written by me alone.
- the thesis submitted has not been previously submitted to this university or any other.
- that all content, including primary and/or secondary data, is true to the best of my knowledge.
- that all quotations and references have been duly acknowledged according to the requirements of academic research.

I understand that to knowingly submit work in violation of the above statement will be considered by examiners as academic misconduct.

Abstract

Replace with your abstract text of not more than 300 words.

Keywords:

Replace with at least 6, semicolon separated keywords (not contained within the thesis title) – this makes the thesis searchable.

Acknowledgements

The author would like to thank . . .

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List of Abbreviations

SATM	School of Aerospace, Technology and Manufacturing
SEEA	School of Energy, Environment and Agrifoods
CDS	Cranfield Defence and Security

Chapter 1

Guidance

For Chapter Titles use `\chapter{chapter title}` and add an optional `\label{label name}` for easy cross referencing.

1.1 The Title Pages

The two title pages and the *Academic Integrity Declaration* are created using the `\maketitle` command. However, information for the title pages is set in the preamble (before `\make{document}`) using various commands. Title, author and date are set using the standard L^AT_EX commands `\title`, `\author` and `\date`. Other commands are included by `cranfieldthesis.sty` as we now detail.

1.1.1 Supervisors

If there is a single supervisors (plus one or more associate supervisors - see Sec. 1.1.2) then use `\supervisor`,

```
\supervisor{Dr First A. Supervisor}
```

But, if there are two or more then use `\supervisors` with appropriate use of `and`, `com-`, `mas`, or `\\` (for a line break) to separate them,

```
\supervisors{Dr First A. Supervisor and Prof Second Supervisor}
```

or,

```
\supervisors{Dr First A. Supervisor, Prof Second Supervisor\\  
and Third Supervisor}
```

You must set either the `\supervisor` or `\supervisors`.

1.1.2 Associate Supervisors

If there is a single associate supervisor then use `\associatesupervisor`,

```
\associatesupervisor{Dr Associate Supervisor}
```

But, if there are two or more then use `\associatesupervisors` with appropriate use of and, commas, or `\\` (for a line break) to separate them,

```
\associatesupervisors{Dr Associate Supervisor and Prof. Yet Another}
```

If you do not set the associate supervisor(s) then nothing is displayed.

1.1.3 School, Course, Degree and Academic Year

Additional information on which Cranfield School of study and which course was undertaken are which degree is being sought are set using `\school`, `course`, `degree` and `\academicyear`.

1.1.3.1 School

Use command `\school` to set your Cranfield School of study. There are predefined commands for each of our 4 schools. So you might use

```
\school{\CDS}
```

for Cranfield Defence and Security. Other schools may be specified using `\SATM`, `\SOM` or `\SWEE`.

1.1.3.2 Course

Use command `\course` to set your course title. e.g.,

```
\course{Military Operational Research}
```

If this command is not set then no course title is written.

1.1.3.3 Degree

Command `\degree` is used to set your degree of study.

For taught programmes (2) this should be one of

- MSc
- MBA
- MTech
- MRes
- MDes
- PgDip
- PgCert

For research programmes (3) this should be one of

- PhD
- Executive DBA
- EngD
- MPhil
- MSc by Research

For example,

```
\degree{MSc}
```

1.1.3.4 Academic Year

Aside from the usual `\date` which should be used to supply the month and year of your thesis submission, you should also use `\academicyear` to supply the academic year. For example,

```
\academicyear{2022--2023}
```

1.1.4 Copyright

The copyright year must be supplied, this will be the same as the year of submission. For example,

```
\copyrightyear{2023}
```

By default, a Cranfield University copyright statement is displayed. MOD sponsored student theses will usually be Crown Copyright, and should use the following command:

```
\copyrightholder{Crown Copyright}
```

Do something similar if your copyright belongs to anyone else.

1.1.5 Fulfilment

By default the statement,

This thesis is submitted in partial fulfilment of the requirements for the degree
of ...

is added to the second title page. This should be removed for degrees assessed entirely by the thesis, such as a PhD, by using the command,

```
\fullfillment{}
```

in the preamble.

1.2 Section Heading

For section headings use `\section{section name}` and add an optional `\label{label name}` for easy cross referencing.

1.2.1 Subsection heading

For subsection headings use `\section{subsection name}` and add an optional `\label{label name}` for easy cross referencing.

1.2.1.1 Referring to headings

Avoid referring to other parts of your document using phrases such as “*as described below*” (unless on the same page, this could be anywhere in the rest of the thesis) or “*as described previously*” (this could be anywhere from the start of the thesis). Instead make use of the chapter and section labels to point the reader directly to the appropriate part of the thesis.

Command `\refchap{label name}` has been defined to make it easy to cross-reference chapters. Similarly, `\refsec{label name}` is used to cross-reference section, subsection and subsubsection numbers. These commands should be used when the cross-reference occurs mid-sentence to facilitate their abbreviation. For example, to produce

In Chapter 1 we provide guidance on formatting your thesis including, in Sec. 1.2, section headings.

use:

In `\refchap{chap:Guidance}` we provide guidance on formatting your thesis including, in `\refsec{sec:SectionHeading}`, section headings.

At the start of sentences use commands `\refChap{label name}` and `\refSec{label name}` to ensure abbreviations for Chapter and Section are not used. For example,

Chapter 1 provides guidance on formatting your thesis including. Section 1.2 covers section headings.

is produced using

`\refChap{chap:Guidance}` provides guidance on formatting your thesis including. `\refSec{sec:SectionHeading}` covers section headings.

At the time of writing, `\refChap` and `\refchap` produce the same output, but both are included for completeness and in case guidance changes in the future.

1.3 Chapter and Section Page Breaks

Use of the `\chapter` command will automatically start a new page. Use of `\section`, `\subsection` and `\subsubsection` will not. If a page break is desired for improved formatting (e.g. a section title appears as the last line on a page and its text appears on the next), then use `\pagebreak` to force a new page where you need it.

1.4 The Cranfield University logo and co-branding

It is preferred that the Cranfield University logo is positioned at the top of the cover and title pages of the thesis document. The logo image files is provided as `CULogo.png` with this template and included by default. (It can also be specified using the command `\setCULogo`.)

If it is not appropriate to show the Cranfield University logo, then it can be removed and replaced by the text as described in Sec. 1.4.1.

If you are working with a partner on the research included in this thesis document, you may, subject to their approval, also include their official logo as co-branding on the cover and title pages. Guidance is provided in Sec. 1.4.2.

1.4.1 Using Cranfield University text in place of a logo

If appropriate you may remove the Cranfield University logo from the cover and title pages of the thesis and in its place use the text “CRANFIELD UNIVERSITY”.

To remove the Cranfield logo issue the command

```
\setCUTextLogo
```

1.4.2 Adding a partner logo

Before using a partner logo in this document you must:

- obtain permission from the partner to use their logo in this document.
- obtain a high-resolution logo from the organisation – do not take a screen-shot from the website.

To add the partner logo as co-branding use

```
\setCUPartnerLogo{PartnerLogo}
```

where `PartnerLogo.png` or `PartnerLogo.jpg` is the graphics file containing your partner’s logo. A dummy `PartnerLogo.png` is supplied with this template.

The Partner Logo is automatically scaled to be the same width as the CU Logo. This might not be appropriate if the logo is wider than tall. In that case experiment with the command `\setCUPartnerLogo` in the style file `cranfieldthesis.sty`. You may wish to consult (4, 5) for support in doing so.

1.5 Inserting captions in the main document

Captions should be used whenever you insert a graphic or table. Use the `\caption` command to create the caption and add a `\label` for cross-referencing.

1.5.1 Figures - graphs, photos, diagrams

A \LaTeX `\figure` environment should be used to insert graphs, photos and diagrams - here I'm also using them for \LaTeX code listings (an alternative would be to set up a new environment for listings and use a better \LaTeX package for displaying it (6, 7, 8)). The caption should be placed below the figure. An example is shown in Fig. 1.1. This was



Figure 1.1: A figure caption

coded using the following:

```
\begin{figure}[ht]
\begin{center}
\includegraphics[width=0.8\textwidth]{FigureExample}
\end{center}
\caption{A figure caption}
\label{fig:FigureExample}
\end{figure}
```

Note the figure placement options `[ht]` to place the figure as best as possible either (`h=`) here (at the place where coded) or at the (`t=`) top of the page. Otherwise it will be placed on the following page.

If you wish to include sub-figures, that is two or more graphs, photos or diagrams alongside each other with the same main caption then consider using the `subfigure` package (9)

1.5.2 Tables

A \LaTeX `\table` environment should be used to insert tables, with the table itself generated using the `\tabular` environment. An example is shown in Tab. 1.1. The caption

Table 1.1: A table caption

	Heading	Heading
Label	Detail	Detail
Label	Detail	Detail

should be placed above the table. The coding to achieve this is:

```
\begin{table}[ht]
\caption{A table caption}
\begin{center}
\begin{tabular}{l|l|l}
& Heading & Heading \\ \hline
Label & Detail & Detail \\ \hline
Label & Detail & Detail \\ \hline
\end{tabular}
\end{center}
\label{tab:TableExample}
\end{table}
```

1.5.3 Equations

Equations with labels are easily coded in \LaTeX using the `equation` and `\label` environment,

$$A = \pi r^2. \tag{1.1}$$

This is coded as

```
\begin{equation}
A=\pi r^2. \label{eq:circlearea}
\end{equation}
```

Remember to punctuate your equation with a period if it ends a sentence.

Equations should only be labelled if they are cross-referenced later. Use `\[. \]` for an unlabelled equation,

$$A = \pi r^2.$$

For a derivations it is often useful to use the `eqnarray` environment. For example, multiplying out a quadratic,

$$\begin{aligned} y &= (x-3)(x+4) \\ &= x^2 + x - 12 \end{aligned} \tag{1.2}$$

with `\nonumber` used to label constituent equations that do not need labelling. This is coded as

```
\begin{eqnarray}
y&=&(x-3)(x+4) \nonumber \\
&=&x^2+x-12 \label{eq:quadraticarray}
\end{eqnarray}
```

1.5.4 Referring to captions for figures, tables etc.

We can reference figures, tables and equations using supplied `\refFig`, `\reffig`, `\refTab`, `\reftab`, `\refEqn` or `\refeqn` according to what we are referencing, and whether we are doing so at the start of a sentence or not. Here are some examples:

- Table 1.1 at start of a sentence

`\refTab{tab:TableExample}` at start of a sentence

- Within sentence reference to Tab. 1.1

`\item Within sentence reference to \reftab{tab:TableExample}`

- Equation (1.2) at start of a sentence

`\refEqn{eq:quadratic}` at start of a sentence

- Within sentence reference to (1.2)

`\item Within sentence reference to \refeqn{eq:quadratic}`

1.5.5 Updating Tables of Contents, Lists of Figures and Labels

The information for contents, figures, tables and labels and cross-referencing for \LaTeX are enabled using various files: `.toc` (table of contents), `.lof` (list of figures), `.lot` (list of tables).aux file. e.g., e.g., for this \LaTeX file `LaTeX_Thesis_Template.toc`, `LaTeX_Thesis_Template.lof`, `LaTeX_Thesis_Template.lot` and `LaTeX_Thesis_Template.aux` are created. The labels, captions etc are written to these files when a command such as `\chapter` or `\label` when processing the \LaTeX file (e.g., when running `pdflatex`). The labels, chapter names etc. are also read from this file to generate the table of contents, list of tables, cross-references. As a result you will need to process the file at least twice to get the table of contents, list of tables and cross-references correctly updated.

Sometimes these files may get corrupted if the labels, chapter names etc are not correctly coded. In this case you will need to remove the `.toc` (table of contents), `.lof` (list of figures), `.lot` (list of tables).aux files. There is often a simple menu option to do this if using \LaTeX through a GUI tool such as TeXworks for which the drop down *File – Remove Aux Files ...* may be used.

1.6 Inserting Landscape Pages

It is often preferable to use a landscape page to display tables of data, charts or diagrams. This is most easily done by using the `landscape`



Figure 1.2: A figure on a rotated page caption

`package (10)` and placing the `LATEX` source for the content to be created with the `landscape` environment.

```
% preamble  
% :  
\usepackage{landscape}
```

```
%  
\begin{document}  
% :  
\begin{landscape}  
% source for landscape material  
\end{landscape}
```

Chapter 2

Referencing

The University specifies that you should use the APA7 Author-Date (11) or the Cranfield Numbered (12) citation styles as advised by your course director or supervisor.

2.1 Cranfield APA7 Author-Date Referencing

While this author has not used it, the L^AT_EX bib style apa7 (13) should permit the use of the University's APA7 Author-Date Referencing style (11).

2.2 Cranfield Numbered Referencing

Ensure the following lines are uncommented in the preamble to the template file.

```
\usepackage[numbers]{natbib} % for nice referencing
\makeatletter % Reference list option change to number and period
\renewcommand\@biblabel[1]{#1.} % from [1] to 1
\makeatother %
\setcitestyle{round} % use round citations
```

The bibliography style is coded in the CranfieldNumbered.bst bibliography style file so this must be stated using the \bibliographystyle command

```
\bibliographystyle{CranfieldNumbered}
```

This bibliography style file has been adapted from that of the standard Vancouver system (14).

We now cover a few of the examples from Cranfield Numbered Style (12).

2.2.1 Books

Book with a single author According to Sommerville (15, p.35) the most important part of software engineering is...

Book with two authors Stair and Reynolds (16, p.65) suggest...

Book with four or more authors This was noted by Payne et al. (17, p.15)

Book with an editor Latest thinking on gender in organizations suggests. . . (18)

Chapter of an edited book Haase (19, p.35) identified...

Chapter of an edited book with organisation as author e.g. handbooks The steel corrosion showed . . . (20)

Book with no author In order to vote in the UK. . . (21)

Electronic book (eBook) or an online book The project manager's role can be defined as. . . (22)

Book accessed via an eReader e.g. Kindle, iPad etc. Brodie tried to decipher the code (23)

NOTE: Place eReader type in square brackets at the end of the bibtex title field

Translated Book In his discussion about algebraic topology, Matveev (24, p.17) considered...

Translator not yet supported

2.2.2 Journal Articles

Journal article with one author A recent article discussed the fracture... (25).

Journal article with two or three authors It was not possible to separate targets (26).

Journal article with four or more authors Langley et al (27) identify assumptions. . . Note the use of the \etal command for the correct, non-italicised, et al.

Online journal article with DOI The synthesis of a new polymer of cadmium(II) ethylenediamineazide was determined by . . . (28).

Online journal article with URL The synthesis of a new polymer of cadmium(II) ethylenediamineazide was determined by . . . (29).

NOTE: The bibtex style file does not support the accessed attribute so include it in the note field of the bibtex entry.

Journal article with no author TC-32B QT was demonstrated at an exhibition held in Kent (30).

2.2.3 Conference Papers

NOTE: Use bibtex entry incollection.

Full conference proceeding The IEEE (31, p.59) suggests that . . .

Individual paper Moon and Koh (32) provide computations . . .

NOTE: Place paper number in the bibtex number field.

Online proceeding or paper Wessel and Meyer (33) provide a ten step method. . .

Offshore Technology Conference (OTC) paper According to Chiasson, Smith and Steward (34) large bore . . .

2.2.4 Internet

NOTES:

- The bibtex style file does not support the accessed attribute so include it in the note field of the bibtex entry.
- If using Zotero then use a document and not a web entry as the publisher field is often used

Web page with an individual author Bradley (35) states that libraries and . . .

Web page with an organisation as author The Natural Hazards Centre (36) advised that . . .

Blog Julian Borger (37) claims in ‘Afghanistan options are running out’ . . .

NOTE: add [Blog] to end of title field.

Wiki The CILIP ARLG National committee meeting notes show... (38) **NOTE: add [Wiki] to end of title field.**

2.2.5 Thesis or dissertation

Print thesis or dissertation An examination of Forth’s (39) research shows that. . .

Online thesis or dissertation Tatham (40) identifies three areas undergoing notable change. . .

NOTE: use of question mark in thesis title is not presently detected in bibtex style file.

2.2.6 Course materials

Lecture or seminar The lecture provoked much debate (41)

Lecturers’ notes on Virtual Learning Environment e.g. Canvas As illustrated in the course materials (42)

Course Virtual Learning Environment discussion forum The debate during the lecture continued in the discussion forum. Hirst (43) was particularly vociferous.

2.2.7 Official Publications

Note: These have not been tested yet but can probably be achieved with a bibtex misc entry.

UK Statute (Act of Parliament)

House of Commons or House of Lords Paper

House of Commons or House of Lords Bill

Statutory Instruments (SIs)

Hansard Debate

Command Paper (Green or White Paper)

European Directive

2.2.8 Reports

Report An analysis of China's investment in companies in different countries has shown... (44).

Online report The effect was. . . (45).

Note: Presently unable to get colon (:) between report number and report title.

Online industry or market research report Media trends in the UK. . . (46)

Online company or annual report Despite economic uncertainty the company's profits did increase (47).

Online company or financial report or data source Rolls-Royce plc turnover has dramatically reduced in 2009-2010 (48).

2.2.9 Case Studies

Note: These have not been tested yet but can probably be achieved with a bibtex misc entry.

2.2.10 Working Papers

Note: These have not been tested yet but can probably be achieved with a bibtex misc entry.

2.2.11 Newspapers

Note:

- Use `bibtex misc` type, `zotero`
- If needed place edition (e.g. Evening Ed.) in the Newspaper (`bibtex journal` field) title.

Printed newspaper article A blast at an atomic weapons factory was met with denials by Iran (49).

Note: Use `bibtex misc` type, omit date from year field and place date in `note` field.

Article from an online newspaper Rayner (50) reports that The Royal British Legion Centre for Blast Injury Studies is to design. . .

2.2.12 Standards, patents, protocols and datasheets

Note:

- Use `bibtex report` item
- Presently unable to get colon (:) between report number and report title.

Standard In projects "specification, schedule and cost always have to be bounded to ensure ongoing viability" (51).

Online standard from a database Some standards provide guidelines for effective project management (51).

Patent The method of assembly... (52)

Joint Service Publication or protocol The MOD has a simple definition of knowledge (53).

Note: As the actual url is not available, put the availability and accessed data in the `bibtex note` field.

Datasheet e.g. ESDU The buckling of the panel... (54).

2.2.13 Datasets and software

- Use `bibtex misc` type.
- Include version number in parenthesis in the `title` field.

Dataset Data from Partridge (55) showed . . .

Software Plone is an example of this sort of use of an open source content management system (56).

2.2.14 Audio visual materials

Note: These have not been tested yet but can probably be achieved with a bibtex `misc` entry.

2.2.15 Images

Notes:

- Use `misc` type
- For items available online so include the `accessed` attribute in the `note` field of the bibtex entry.

Illustration, figure, diagram, logo or table The estimated sales forecast is shown in Fig. 2.1.

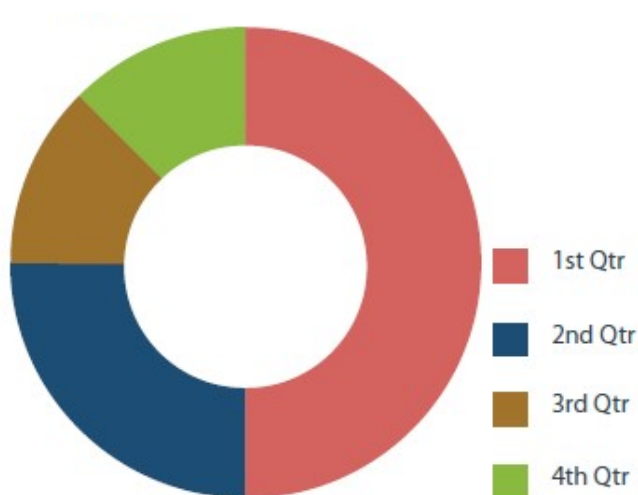


Figure 2.1: Estimated Sales Forecast (1, p.4)

Embedded illustration, cartoon, diagram, etc. The pressure on the housing market... (57).

Note: Include the `[medium]` , here a `[cartoon]` at the start of the bibtex title field.

Ordnance Survey map P.O. equates to Post Office (58).

Note:

- Use the `title` field to add the map number and scale.
- Use the `note` field to add the map series.

Online map There are many farms in the area (59).

Note: The bibtex style file does not support the `accessed` attribute so include it in the `note` field of the bibtex entry.

Painting or drawing **Note:** This has not been tested yet but can probably be achieved with a bibtex misc entry.

Painting or drawing online Groves' *Carrot on a stick* (60) is playing with colours.

Photograph – print or slide Sublime lighting captures the atmosphere wonderfully (61)
Note: I uses a book entry here.

Photograph online or in an online collection e.g. Flickr, Instagram An abundance of movement is captured (62).

2.2.16 Personal communications

Notes:

- Use misc type
- If dates are not fully listed then place them in the note field.

Email or letter The details of the organisational structure were outlined (63).

Conversation It was felt the organisational culture changed when the new CEO arrived (64).

Interview, survey or questionnaire The theory was dismissed as nothing new (65).

Chapter 3

Dealing with chapters whose chapter name is ridiculously long and so spoiling formatting

Apart from new chapter pages, the style file automatically uses the current chapter and section names for the left and right headers of the pages of the main body. This can cause problems if the chapter or section names are too long. To cope with this, when you define the new chapter, also define a shortened chapter name in square brackets as we have for this chapter,

```
\chapter[Dealing with long chapter names]{Dealing with chapters whose  
chapter name is ridiculously long and so spoiling formatting}
```

Section 3.1 shows how to do this for sections.

Note that the short chapter and section names are also used in the table of contents so try to avoid long names if possible.

3.1 Dealing with sections whose section name is ridiculously long and so spoil formatting

For long section names it's advisable to provide a short section name

```
\section[Dealing with long section names]{Dealing with sections whose  
section name is ridiculously long and so spoil formatting}
```

Chapter 4

More Topics

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

Chapter 5

Final Topic

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

Chapter 6

Conclusions

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

References

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2. Cranfield University. Taught degrees; 2023. Available at: <https://www.cranfield.ac.uk/study/taught-degrees/taught-degrees-at-cranfield>.
3. Cranfield University. Research degrees; 2023. Available at: <https://www.cranfield.ac.uk/research/research-degrees>.
4. Carlisle D, Rahtz S. CTAN: Package graphicx; 2021. Available at: <https://ctan.org/pkg/graphicx?lang=en>.
5. The LaTeX Project Team, Mittelbach F. CTAN: Package array; 2022. Available at: <https://www.ctan.org/pkg/array>.
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Appendix A

Ethical Approval Letter

Insert your Ethical Approval Letter as the first appendix.

Appendix B

Extra Data

This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text. This is a sample of thesis text.

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